

SELF-ALIGNING CUTTER HUB ASSEMBLY

BACKGROUND OF THE INVENTION

5       Field of the Invention

      The present invention generally relates to a self-aligning cutter hub assembly mounted on the end of the drive shaft of an underwater pelletizer which orients the cutter hub and blades mounted thereon in optimum aligned relation to the die face of the extrusion die plate of the underwater pelletizer. More specifically, the present invention represents an improvement on the self-aligning cutter hub structure disclosed in U.S. Patent No. 10       ✓ 5,624,688 (owned by the Assignee of the present application) and includes an assembly retainer in the form of spring pins or 15       attachments to retain the self-aligning cutter hub elements within

the bore of the cutter hub when the underwater pelletizer is disassembled.

Description of the Prior Art

Underwater pelletizers for forming plastic pellets by the use of an extrusion die having orifices through which molten polymer is extruded out from a die face for engagement by cutter blades mounted on a rotatable cutter hub and driven by a drive shaft are well known. One of the characteristics of underwater pelletizers is the desirability of maintaining the cutter blades and die face in properly aligned relation in order that the cutting edge of the blades on the rotating cutter hub move in very close parallel relation to the die face. This close parallel relationship allows the blades to efficiently cut the extruded plastic into pellets as the plastic strings are discharged from the orifices in the extrusion die plate and prevents unnecessary wear of the cutter blade and/or die plate face. The following additional U.S. patents, also owned by the Assignee of this application, relate to underwater pelletizers, cutter hub assemblies and structures for positioning the cutters and cutter hub in desired relation to the die face of the die plate:

4,123,207	4,621,996	5,403,176
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4,251,198	4,728,276	
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4,500,271	5,059,103	
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The above referenced patents, and the references cited in those patents, which are incorporated herein as if fully identified,

disclose various underwater pelletizer structures and components thereof.

With respect to U.S. Patent No. 5,624,688 this patent discloses a self-aligning cutter hub assembly which connects the  
5 cutter hub to the pelletizer drive shaft. The assembly transmits torque from the drive shaft to the cutter hub while at the same time allowing limited universal movement of the cutter hub in relation to the rotational axis of the drive shaft. This universal movement enables the cutter blades on the cutter hub to maintain  
10 optimum parallel relation to the die face of the extrusion die plate to efficiently cut the extruded plastic material into pellets. The structure connecting the cutter hub to the drive shaft also enables effective assembly and disassembly of the components of the cutter hub onto and off of the end of the drive  
15 shaft.

More specifically, the cutter hub of the '688 patent includes a central bore defining an inner surface and an adapter received in the bore and fixedly attached to the end of the drive shaft. The inner surface of the hub bore and the outer surface of  
20 the drive shaft adapter are provided with corresponding partial spherical surfaces which coact to enable the requisite universal movement of the cutter hub in relation to the drive shaft. The drive shaft adapter is mounted on the end of the drive shaft, as by screw threads or the like, and the adapter and hub bore each  
25 include diametrically arranged recesses for partially receiving spherical balls which transmit the driving torque from the drive shaft to the cutter hub.

The recesses on the inner surface of the cutter hub bore are preferably diametrically opposed axial recesses or grooves which extend inwardly from one end surface of the cutter hub but do not extend completely to the other end surface of the cutter hub.

5 The inner surface of the cutter hub bore also includes a short circumferential recess extending from each edge of the axial recess or groove and opening to the end surface of the cutter hub open to the axial recess. The recesses enable the adapter and torque transmitting balls to be assembled into the bore of the cutter hub  
10 when the adapter is oriented in perpendicular relation to the surface of the cutter hub. The drive shaft adapter can then be rotated 90° to register the partially spherical inner surface in the bore of the cutter hub with the partial spherical outer surface of the adapter.

15 The recesses or grooves in the inner surface of the cutter hub bore receive the torque transmitting balls during assembly of the drive shaft adapter with pivoting of the adapter into final position locking the torque transmitting balls in position. The adapter can then be assembled onto the drive shaft,  
20 such as by a screw threaded engagement between the drive shaft and adapter or other engagement assembly.

#### SUMMARY OF THE INVENTION

When handling the self-aligning cutter hub assembly as disclosed in the '688 patent, either when assembling for  
25 installation in the pelletizer or when disassembling to change or adjust components of the pelletizer, in some instances, the drive

shaft adapter can pivot to a position perpendicular to the cutter hub. In this position, the adapter can fall out of or disassemble from the hub by gravity if the hub is supported with the open ends of the axial recesses facing downwardly or when a force is applied to the adapter that would move the balls out of the axial recesses or grooves in the hub. When this occurs, the torque transmitting balls may fall out of the recesses in the adapter and become lost or require considerable time and effort to locate. Then additional time is required to reassemble the balls, adapter and cutter hub.

In order to overcome the foregoing difficulty, the present invention provides an assembly retainer for the cutter hub which includes a structure that places an obstruction in the open end area of the axial recesses. This obstruction then prevents the torque transmitting balls from moving out of the axial recesses thereby maintaining the hub, drive shaft adapter and balls in assembled relation when the self-aligning cutter hub is not assembled on the drive shaft such as when components of the cutter hub are being replaced, adjusted and the like.

In one embodiment, the assembly retainer for the self-aligning cutter hub includes a circular plate or washer associated with the open end of each axial recess in which a torque transmitting ball is positioned to prevent the ball from exiting the open end of the axial recess. The ball retaining plates or washers are secured to the cutter hub by the use of a screw threaded fastener or the like extending into the end surface of the cutter hub to which the axial recess opens, thereby retaining the

adapter, balls and cutter hub in assembled relation and preventing accidental disassembly when the cutter hub is being handled, attached to the drive shaft, detached therefrom or otherwise not associated with a die plate or drive shaft.

5           In a second embodiment, the assembly retainer for the self-aligning cutter hub includes spring pins inserted in angular passageways in the cutter hub which communicate with the open end of the axial recesses in the bore of the cutter hub. A spring pin is inserted in each of the angular passageways with one end of each  
10       spring pin terminating in the end of the axial recess and forming an obstruction to prevent the torque transmitting balls from exiting the axial recesses in the cutter hub and limiting the pivotal movement of the cutter hub in relation to the adapter during assembly, disassembly and adjustment of the cutter hub.

15           Preferably, the cutter hub and drive shaft adapter are each provided with four recess arrangements oriented at 90° positions around their circumference. Having four recess arrangements facilitates maintenance and enhances the life of the self-aligning cutter hub by enabling an operator of the pelletizer  
20       to initially use one set of the diametrically opposed recesses in the outer surface of the adapter, one pair of balls and one set of recesses in the inner surface of the bore together with appropriate retainers. Then, after requisite use and wear, the pelletizer operator may remove the assembly retainer, disassemble  
25       the adapter and balls from the hub and then reassemble the adapter, balls and hub utilizing the previously unused set of diametrically opposed recesses in the adapter and hub and inserting the retainers

in the same manner as when oriented in relation to the originally used recesses. Optionally, a new set of balls may also be used if the original balls show any evidence of wear. As such, the present invention enables a prolonged useful life of the self-aligned cutter hub which will be retained in assembled relation by the assembly retainers during handling, assembly, disassembly and adjustment of the cutter hub assembly.

Accordingly, it is an object of the present invention to provide a self-aligning cutter hub assembly which includes an assembly retainer to keep the torque transmitting balls from coming out of the cutter hub axial recesses when the components of the cutter hub are being replaced, adjusted and the like.

Another object of the present invention is to provide a self-aligning cutter hub with an assembly retainer which keeps the drive shaft adapter from inadvertently disassembling from out of the cutter hub bore during handling, assembly, disassembly and adjustment of the cutter hub assembly.

A further object of the present invention is to provide a self-aligning cutter hub assembly with an assembly retainer which keeps the cutter hub from coming apart when the hub is handled improperly during replacement, adjustment, etc. of the pelletizer components.

Still another object of the present invention is to provide a self-aligning cutter hub assembly which has a prolonged useful life by reason of a duplicate pair of diametrically opposed recesses in the cutter hub and drive shaft adapter, thus providing duplicate assembly arrangements.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout.

#### BRIEF DESCRIPTION OF THE DRAWINGS

6 Figure 1 is a sectional view of a <sup>conventional</sup> pelletizer illustrating a self-aligning cutter hub associated with other components of a pelletizer.

Figure 2 is an end elevational view of the cutter hub assembly of the present invention without the cutter knives and illustrating the orientation of the components of the hub in a first embodiment of the assembly retainer.

15 Figure 3 is a sectional view, on an enlarged scale, taken along section line 3-3 on Figure 2, illustrating the matching relationship between the exterior of the adapter, the interior of the bore in the cutter hub, the torque transmitting balls and the assembly retainer in the form of circular plates retaining the balls in the axial recesses in the hub bore.

Figure 4 is an end elevational view of the cutter hub assembly of the present invention without the cutter knives and illustrating the orientation of the components of the hub in a second embodiment of the assembly retainer.

25 Figure 5 is a sectional view, on an enlarged scale, taken along section line 5-5 on Figure 4, illustrating the matching

relationship between the exterior of the adapter, the interior of the bore in the cutter hub, the torque transmitting balls and the assembly retainer in the form of spring pins retaining the balls in the axial recesses in the hub bore.

## 5     DESCRIPTION OF THE PREFERRED EMBODIMENTS

Although only two preferred embodiments of the invention are explained in detail, it is to be understood that the embodiments are given by way of illustration only. It is not intended that the invention be limited in its scope to the details  
10 of construction and arrangement of components set forth in the following description or illustrated in the drawings. Also, in describing the preferred embodiments, specific terminology will be resorted to for the sake of clarity. It is to be understood that each specific term includes all technical equivalents which operate  
15 in a similar manner to accomplish a similar purpose.

Referring now to Figure 1 of the drawings, this drawing illustrates an underwater pelletizer structure with a self-aligning hub incorporated therein as shown in the '688 patent. The pelletizer includes an inlet housing 10 having an inlet passageway  
20 12 for receiving molten polymer from upstream equipment. The molten polymer is diverted outwardly by a nose cone 14 and enters into a plurality of extrusion orifices 16 in a die plate 18. The die plate 18 is secured to the inlet housing by fastening bolts or the like 20 and typically is provided with heating elements 22  
25 located in cavities 24 in the die plate. The die plate includes a

die face 26 of wear resistant material which is mounted on the die plate along with heat transfer plates 28.

Attached to the housing 10 and die plate 18 is a cutter chamber generally designated by reference numeral 30 which includes a circulating water inlet passageway 32 and a discharge passageway 34 for the water and entrained pellets. The cutting chamber includes a flange 36 attached to the die plate and housing and a flange 38 at the opposite end thereof having an inclined surface 40 for association with a similar flange on an adapter connected to a drive unit. A drive shaft 42 extends through the cutter chamber 30 and supports and drives a cutter assembly generally designated by reference numeral 44. The cutter assembly 44 includes a cutter hub 46 and a plurality of cutter knives 48 having their cutting edge associated with the die face 26 and the discharge point of the orifices 16. The cutter hub includes two end surfaces, one end surface 47 faces the die plate 18 and the other end surface 49 faces away from the die plate toward the drive motor (not shown). All of the above mentioned structure is known. The present invention relates specifically to the cutter hub 46 and the manner in which the components thereof are retained in assembled relation.

As illustrated in Figure 2, the cutter hub 46 includes a plurality of arms 50, each having notches 52 which receive the cutter blades that are secured by the use of conventional fasteners threaded into threaded bores 54 as is well known in the art. The arms 50 are integral with the central portion 51 of hub 46. The hub 46 is provided with an axial bore 58 which extends therethrough and which has an inner face that is partially spherical as

indicated by reference numeral 60 in Figure 3. Positioned in the bore 58 is a drive shaft adapter 62 having an internally threaded bore 64 extending therethrough. The threaded bore 64 allows the adapter 62 to be screw threadedly connected onto a reduced externally threaded end portion 56 of the drive shaft 42 to form a rigid unit. The exterior surface of the adapter 62 is also partially spherical as indicated by reference numeral 66 in Figure 3. The curvature of the partially spherical surfaces 60 and 66 are matching or corresponding and closely associated as illustrated in Figure 3. As such, the diameter of the partially spherical surfaces at the end edges thereof are less than the diameter at the central portions.

The partially spherical exterior surface 66 of the adapter 62 is provided with a pair of diametrically opposed generally semispherical recesses 68 oriented equally distant from the end edges of the partially spherical surface 66 as illustrated in Figure 3. Received in each of the semispherical recesses 68 is a spherical ball 70.

The hub bore 58 includes a pair of diametrically opposed axial, semicylindrical recesses 72 which extend inwardly from end surface 49 of the hub bore. The recesses 72 terminate at their inner ends in a partially spherical inner end 74 which is adjacent but spaced from the opposite end surface 47 of the bore 58. The recesses 72 receive the balls 70 which provide the torque transfer from the shaft 42 and adapter 62 to the hub 46.

In order to assemble the adapter 62 and balls 70 with respect to the bore 58, the bore 58 includes an axial recess 76 in

end surface 49 which extends circumferentially a short distance from the edges of the recess 72 and terminates with an inner end spaced from the spherical portion 74 of the recess 72. The recesses 76 are provided to enable the partially spherical surface 66 of the adapter 62 to be inserted into the bore 58 when the adapter 62 is oriented in substantially perpendicular relation to the bore. The balls 70 are placed and retained in the cavities 68 in a suitable manner, such as by the application of grease or the like. With the adapter 62 in substantially perpendicular relation to the hub 46, the balls 70 can be received in the recesses 72 when the assembled adapter 62 is moved into the bore 58. The bore 58 does not block the larger diameter central portion of the surface 66 of the adapter 62 because of recesses 76 in end surface 49. When the balls 70 reach a central point between the two ends of the bore 58, the adapter 62 can be rotated 90° into the bore 58 with the partially spherical surfaces 60 and 66 being in close registry as illustrated in Figure 3. The curvature of the surfaces 60 and 66 then serves to retain the adapter 62 within the bore 58 and retain the balls 70 in the recesses 68 and 72.

The balls 70 transmit driving torque and the surfaces 60 and 66 enable the hub 46 to pivot universally in relation to the drive shaft. This universal movement enables the cutter hub 46 and cutter knives 48 to remain oriented in parallel closely spaced relation to the die face 26 for efficiently cutting the extruded plastic into pellets regardless of angular variation in the drive shaft 42.

After the adapter 62 has been assembled into the cutter hub 46 to the position illustrated in Figure 3, the cutter hub and adapter are mounted on the drive shaft 42 by engaging the internal threads 64 of the adapter 62 with the external threads 56 of the drive shaft 42 until the axial recess 80 formed in one end of the adapter 62 receives the shoulder 82 on the end of the shaft. As assembled, the outer spherical surface 66 of the adapter, and the matching inner spherical surface 60 of the hub bore 58, are oriented slightly outwardly of the periphery of the drive shaft in view of the distance between the periphery of the internal recess 80 and the periphery of the surfaces 66 and 60 radially outwardly thereof. This assembly enables the cutter hub to pivot universally on the end of the drive shaft 42 as defined by the adapter 62 which is rigidly secured thereon. While the self-aligning hub has been disclosed in association with a cutter assembly for underwater pelletizers, it can be adapted for other uses in which a rotating component is attached to a shaft to enable the rotating component to align with an associated structure.

The previously disclosed structure and operational procedure of the self-aligning cutter hub correspond with that disclosed in the '688 patent. In order to prevent unwanted and accidental disassembly of the adapter 62 from the cutter hub 46 which could occur when the adapter 62 and the hub 46 assume a substantially perpendicular relation, such as when the cutter hub assembly is separated from the drive shaft, the present invention includes an assembly retainer generally designated by reference numeral 90 in Figures 2 and 3. The assembly retainer 90 includes

a circular flat plate or washer 92 associated with each of the axial recesses 72 in the cutter hub 46 that is occupied by a ball 70. The periphery of the plate or washer 92 forms a closure for the end of the recess 72 thus providing an obstruction to prevent exit of the balls 70 from the open end of the recess 72 when the adapter 62 and hub 46 are oriented in a generally perpendicular relation, which occurs by pivoting the adapter 62 about an axis passing through the opposed balls 70. In this position, without the plates or washers 92 being installed, the adapter 62 and the balls 70 can disassemble from the hub 46 as the balls 70 move out of the outer ends of the axial recesses 72 in a manner reverse to the manner of assembling the balls 70 and adapter 62 into the cutter hub 46. The structure of the assembly retainer 90 retains the balls 70 in the axial recesses 72 and prevents unwanted disassembly of the balls and adapter from the cutter hub.

Each of the retainer plates or washers 92 is secured in place preferably by a screw threaded member 94 extending into and in screw threaded engagement with a blind bore 96. The bore 96 extends inwardly into the cutter hub 46 from end surface 49. The fasteners 94 may be provided with a screw driver blade receiving kerf or can be provided with a polygonal periphery for engagement by a wrench or other suitable tool. The retaining plates or washers 92 effectively retain the balls 70 in the recesses 72.

Referring now to Figures 4 and 5, a second embodiment of the assembly retainer is illustrated and designated generally by reference numeral 100. In this embodiment of the invention, the adapter 62 and the balls 70 are the same and their association with

the cutter hub also remains the same. However, in this embodiment, the cutter hub is modified and designated by reference numeral 46'. The assembly retainer 100 includes a pair of angled passageways 102 formed in the hub 46' with one end of the passageway 102 communicating with the open end portion of axial recess 72'. The other end of the passageway 102 terminates flush with end surface 47' of the cutter hub 46'. As illustrated in Figure 5, each of the recesses 72' includes a passageway 102 associated therewith.

Inserted into each passageway 102 is a spring pin 104 which extends through the passageway 102 and into and through a portion of the open end of the axial recess 72'. Thus, the end of the spring pin 104 which extends into the open end of the axial recess 72' forms an obstruction to prevent the ball 70 from exiting the axial recess 72' and functions in the same manner as the assembly retainer illustrated in Figures 2 and 3. The spring pin 104 is a small tubular sleeve that includes a longitudinal slit that can be driven into position and retained in its position by its resiliency. The ends of the spring pin 104 are beveled in a manner to be flush with the surfaces 47' and 49' of the hub 46' and function to prevent the balls 70 from exiting the axial recesses 72' even if the adapter 62 is moved to or assumes perpendicular relation to the cutter hub 46'.

In each embodiment of the invention, the drive shaft adapter 62 is preferably provided with four semispherical recesses 68 and 68' and the cutter hub bore is provided with four axial recesses 72 and 72' and corresponding circumferential recesses. This enables an operator of a pelletizer to disassemble the

components after a predetermined period of use and wear and then reassemble the components using the recesses in the adapter and the cutter hub that were not used during the first period of use. The original balls 70 or new balls can be used depending upon the wear  
5 on the original balls. This enables the operational capabilities of the self-aligning hub to extend over a longer period of use while maintaining optimum efficiency of the hub and cutters attached thereto. Thus, for the embodiment shown in Figure 2, the cutter hub 46 is provided with fastener receiving bores 96 in 90°  
10 spaced relation to those in use. Likewise, for the embodiment shown in Figure 4, passageways 102 are provided in the cutter hub 46' in 90° spaced relation to those which are in use to receive a spring pin. This enables maintenance and upkeep to be enhanced without materially increasing the cost of manufacturing the cutter  
15 hub.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and  
20 operation shown and described, and, accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.